ABSTRACT REVIEW

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ABSTRACT TITLE

Dual photonic-delay-line cross correlation method for the measurement of microwave oscillator phase noise

ABSTRACT TEXT

Measuring the phase noise of low-noise microwave oscillators has always been a challenge. For heterodyne measurement, it is not easy to find low-noise reference microwave oscillators. The delay-line discriminator is the homodyne alternative, which eliminates the need for a low-noise reference oscillator. However, the high loss of electrical delay lines limits the delay to some 100 ns at microwave frequencies, which is too short to characterize high performance oscillators. A better alternative to the microwave line is the photonic delay line. Standard telecommunication fiber SMF-28 has 0.2 dB/km loss. A length of 10 km fiber can be spooled in a very compact package, resulting in about 50 microseconds of delay. To measure microwave signals, we use an electro-optic intensity modulator to modulate the 1.55-μm signal from a semiconductor laser and a high speed photodetector to recover the microwave signal after the delay fiber.

For the photonic delay-line discriminator the noise of microwave amplifiers, optical fibers, and other components limit the achievable noise floor. One way to overcome such a limitation is the cross correlation technique, which was used with rf delay lines some years ago. In our system we can, in principle, eliminate the noise of the components, including the noise of amplifiers and the optical fiber, using cross correlation and averaging. The only component common to the two channels is the power splitter that receives the microwave

signal. All other components, including lasers, modulators, amplifiers, photonic delay lines, and the photodetectors are separate. A dual channel FFT analyzer is utilized for cross correlation measurement. Averaging on 200 samples, the noise floor at 10 kHz offset from the 10-GHz carrier is –146 dBc/Hz for 1.14 km delay fiber, and –160 dBc/Hz for 4.46 km. To our knowledge, this is the lowest noise floor reported for the measurement of microwave signals using the homodyne delay-line discriminator technique, and shows more than 20 dB improvement over the single channel delay-line discriminator. Using the dual photonic-delay-line cross correlation technique, we have measured the phase noise of the coupled opto-electronic oscillator (COEO) that was recently developed. The phase noise of the 9.3 GHz COEO at 10 kHz offset was –140 dBc/Hz, which is at least 10 dB better than the best commercial synthesizers, and thus could not be easily characterized in our lab otherwise.

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KEYWORDS
phase noise
cross correlation
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